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level of the junction of the cord and oblongata. In addition a group of remarkably attenuated cells is found at the origin of the spinal accessory. These cells are so much elongated and their protoplasm has been so much narrowed that but for the discovery of a nucleus in one or the other cell, one might consider them a bundle of axis cylinders. These are better developed in turtles than in the Iguana, and better in fresh water species than in the *Thallassochelys mydas*. In no turtle have I found the cells of the raphe very large, but in the Iguana I have discovered a few very large cells in the same level and location as those first described by Dr. J. J. Mason for the Alligator.

13th. In my first paper I indicated the existence in the Iguana of a hitherto undiscovered pair of lobes or tubercles between the optic and post optic lobes. I have also indicated their homology with a concealed pair in the turtle and alligator. At the time I did not describe the topographical relations minutely. Normally—if I may use the expression—as in the turtle and alligator, the newly discovered ganglia lie at the margin of the central tubular gray of the mesencephalon, in the anterior part of the *corpora quadrigemina*. As we go more posteriorly they are found to extend more dorsally, until in the turtle, for example, they nearly touch in the median line just at the posterior fifth of the optic lobes, where they cease. In the Iguana the relations are the same, but instead of terminating before the posterior margin of the optic lobes, they extend further backwards and prominate at the surface of the brain, as two sharply marked buttons. Their structure is the same in all reptiles so far examined, a molecular basis and small roundish cellular elements. In anterior levels nerve fibres can be seen entering them in strands, from the arched fibre mass which is found beneath the deep gray layer of the optic lobes. Although all surmises as to the function of the inter-optic lobes are as yet strictly hypothetical; yet from the fact that they are directly connected with the central tubular gray, and are under the fascicular subjection of the optic lobes, and that they are well developed in reptiles, and poorly, if at all, developed in mammals, one might suspect them to have some relation to the innovation of the Harderian gland, just as the mesencaphalic nucleus of the fifth pair may be looked upon as the probable centre for the innervation of the lachrymal gland proper.

RECENT PROGRESS OF SCIENCE.

Rev. Samuel Fleming, LL.D., Ph. D.

The progress of science within our own times has been wonderful. Prof. Helmholtz uses the following language: "The contemplation of the astounding activity in all branches of science may well make us stand aghast at the audacity of man, and exclaim with the chorus in the Antigone: Who can survey the whole field of knowlege? Who can grasp the clues, and then thread the labyrinth?" Every department of science has been vastly extended, and every votary of science stimulated to untiring efforts to survey this field, not only, but to enter the secret chambers of knowledge to find the treasures concealed from the human mind, until modern discoveries, modern analysis, and modern invention have combined to make those hitherto hidden facts of science known, and available for practical benefits to human society.

The exact science, Mathematics, has found ample room for the application of its principles and methods of determining the content of all material existences and relations. The sublime science, Astronomy, has reveled in its excursions into illimitable space, adding new triumphs, discovering new facts pertaining to the constitution of the stellar universe, and the relations of the celestial masses, measuring, by the agency of light, the immense distances, magnitudes and motions of the tiny objects which the natural eyes behold in the expanse above, and in former times regarded as "fixed stars." The profound science, Geology, has carried us back into the illimitable depths of past duration, to contemplate the usually slow process by which the earth has been changing from its primordeal, nebulous condition, to that in which it has become fitted for living and rational beings, adding new testimonies of the rocks to the truth of Scripture, expressed by the significant language: "Of old hast thou laid the foundations of the earth." The widely related, efficient science, included in the scope of terrestrial Mechanics, has found abundant use for its forces, and the practical application of its dynamics, in the constantly increasing demands of human society. The splendid and delicate science, Chemistry, has exulted in its new and valuable discoveries in the realm of atoms and molecules, verifying the atomic theory, and adding new evidences that many of the supposed elements of matter are really compounds, and must yield to the searching analysis which finds them to be but molecules composed of two or more atoms. The vast and richly diversified science, Biology, has yielded its living evidences of the progressing series of organic natures, and of the vast scope of its history, extending its relations to ancestries, the periods of whose origin belong to the immeasurable epochs of palæontological history, The crowning, all-conserving science, Anthropology, has added new evidences of its superiority in importance, as it stands highest in the scale of associated sciences; and while it has maintained this highest rank by maintaining the honor of its subject-matter, its votaries have found its latest and greatest achievement in the evidences of a formal psychical constitution as the basis of mental action.

It is not the aim of the writer to pursue the history of the development of the sciences, exhaustively, but to indicate some of the lines of progress.

The brilliant discoveries in Astronomy, within the past few years, have added largely to the wealth of this noble science, fascinating the student, and inspiring to new achievements. Previous to the present century, the solar system included seven primary planets as having at that time been discovered. In the year 1800 a new planet was discovered, and designated an asteroid, or small star,—but it is more properly called a planetoid, or small planet. The name by which this is known is Ceres, after the reputed originator, or god, of corn. It was an event of so great interest to astronomers that it was announced with much eclat that "The long-expected planet between Mars and Jupiter had been discovered." Soon after, three more were observed. Since that time, by means of the greatly increased power of telescopes, more than two hundred have been added by discovery, all being very small. Many others will be found. The problem still to be determined has been, whether these planetoids are "fragments of a broken world," as formerly supposed, or separate condensations from cosmic matter, instead of forming one large body, as in the case of other primary planets. It is not probable, however, that a cosmic mass exploded at any one period, producing such fragments in such positions in their orbits as they maintain, nor that such original mass was so dissipated by the action of a propulsive or radiate force at one time, as to resume its original nebulous state. The second hypothesis is the more probable, viz.: of separate condensations from original nebulosity.

Neptune, one of the largest planets, and nearly twice the distance of Herschel from the sun, was discovered in 1846 by M. Challis, of Paris, and its elements and orbit determined by Le Verrier. The discovery of this planet furnished a satisfactory explanation of the aberrations of the planet Herschel, caused by the approximations of Neptune, though distant, at its nearest point, more than a billion and a half miles. This increase of the number of the solar family furnished an additional illustration, on a grand scale, of the laws of universal gravitation and

of celestial mechanics. Added to this have been discoveries abundantly confirming the theory of stellar motion in groups, clusters and nebulæ, "the places of more than 200,000 stars having already been determined," and we have some conception of the vastness of human achievements, and of the possibilities still awaiting discoveries in this illimitable "field of ether."

The universality and laws of primary force, denominated gravitation, have been subjects of exceeding interest, as they pertain to this primary mode of motion. The fact of an attractive Force acting either upon or within bodies by which they tend to approach each other, arrested the attention, about the year 1600, of the elder Galileo, who extended the principle to all terrestrial bodies, Newton, eighty years afterward, studying this principle, and at the suggestion, it is said, of the fall of an apple, found that there was a definite increase of velocity of bodies approaching the earth, and also that the same kind of attractive force must apply to the moon, while a centrifugal force, either generated from the attractive force, or originated from an extraneous force, continued this secondary planet around the earth. This was the first grand step toward the discovery of the laws of gravitation, applicable to the motion of the earth around the sun, and, generally, to all planets. More recently the principle has been applied to comets, stellar and other masses.

Geology, while below chemistry in the order of nature and classification, had made far less progress in development at the commencement of the present century, a fact which might have been presumed, inasmuch as the latter science has ministered especially to the wants of mankind. According to Buckland, it was at that time "without a name." The general features of geology had been sketched by Leibnitz and Hooke more than a century previous. Near the beginning of the present century the outlines of the subject were classified into three general divisions of formations—the primitive, the secondary and the tertiary. These became the subjects of investigation, historically, in the order named. The first, especially, by Werner, of Germany, who examined chiefly the primitive and transition rocks. The second by Wm. Smith (English), whose observations were first published in 1799. The third by Cuvier and Brougniart whose works upon "Organic Remains" and "Mineral Geography" were published in 1808. During the past half century this science has advanced with other sciences, with vastly increased interest and success, rendering this one of the most fascinating, especially in more recent times, in yielding its stores of facts pertaining to the glacial period, the deposition of metallic substances, experiments showing the order and conditions of the cooling processes, resulting in the different mineral states, and the wonderful revelations of paleontological history, together with many other facts of great interest, but which cannot, in this paper, be especially given. These give abundant confirmation to the theory that immense periods of time, measured by millions of years, have passed during this history, dissipating the doctrine formerly held by many as taught in the Scriptures, that the heavens and earth were created, out of nothing, about six thousand years ago.

Among the departments of science which minister to the wants of human society, none has awakened the spirit of invention and improvement at all to compare with that of Mechanics. With the increase of knowledge, there has been a correspondingly increasing demand for instruments of discovery and analysis, not only, but for the application of scientific skill in the invention of motive powers and the means of the transmission of intelligence, as well as implements of handicraft, of agriculture, etc, The steam power, first utilized by the invention of a machine in 1655, and improved by Watt in 1774, inaugurated its grand work for human society in 1806, when Robert Fulton, after repeated experiments, applied this power to the propulsion of vessels, first on the Hudson river, amazing the thousands who witnessed the successful experiment, and introducing a new propelling power to vessels upon the sea, now bearing their burdens, estimated by millions of tons, on every river and over every lake and sea of earth. This power has added incalculable millions to the material wealth and strength of every civilized nation. The last world-wide application of this power, besides its innumerous minor applications to all kinds of mechanical work, was inaugurated in 1821, when it was successfully applied to the propulsion of railroad trains.

In 1819 Electro-magnetism was first applied to mechanical purposes; and in 1831 the Magnetic Telegraph, for the transmission of intelligence, was invented and successfully applied. And now, even the comparatively coarse medium, air, has aided in business and social communications, at trifling expense, by means of the recently invented Telephone and the Phonograph.

Chemistry has shared richly in the results of recent scientific progress, and has ministered richly to the wants of human society. Three centuries ago, Paracelsus boasted of possessing the "philosopher's stone", by which the baser metals were said to be transmuted into gold; but he gave a new direction to the efforts and objects of Alchemy, insisting that its chief aim should be the preparation of medicines of different kinds for different diseases. But Chemistry, as a science, must date its commencement two centuries later, when the analyses of distinguished scholars, as Scheele, of Sweden, and Dr. Black, of Glasgow University, and the Academies of Science at Berlin and Paris, determined important principles of this science.

The discoveries of Sir Humphrey Davy, in the early part of the present century, gave a new impetus to this branch, leading to chemical analyses and the establishment of chemistry as a science. These have been followed by eras of progress which have brought the subject to a high degree of perfection. Now, the four elements of the ancients, and of the alchemists of comparatively recent times—earth, air, fire, and water—have been found by successive analyses to contain sixty-five elements, the last four having been detected by the new and wonderful method called the Spectrum Analysis. It may be here stated what this method is, for the gratification of any whose attention may not have been called especially to it.

It is well known that a spectrum is an image formed by the light of the sun, or any other luminous body, either as direct or reflected rays, passing through a triangular piece of glass called a prism. The colored lines thus formed by differently refracted and dispersed rays, reveal the nature and qualities of the elements contained in the luminous body by the different colors, combinations, and the phenomena presented, compared with previous results of experiment in the laboratory, upon light reflected from different mineral substances. It has been found that every kind of mineral substance, whether in the form of a solid, gas, or nebulous matter, when in a state of intense luminosity, possesses the capacity to emit a specific color, with its accompanying mixed lines. This being known, when a new body is analysed by its light, its constituents are determined by the lines of light. Thus the solar envelopes, protuberances, etc., of the sun are examined by the analysis of the solar spectrum. By this method, the character of comets, meteors, or other celestial masses are determined. By this the problem of the sudden appearance or disappearance of stellar masses is explained, by determining the state of the mass thus emitting light, and the conditions of luminosity. What the telescope has failed to determine in respect to the elements and qualities of bodies, or the nature of nebulous masses, whether such masses are clusters of stars in the infinite distance, or of original, unformed nebulous matter, the spectroscope has accomplished; and what has been held by most astronomers as a theory, has become

confirmed as a fact, that, as Prof. Schellen says, "luminous nebulæ actually exist as isolated bodies in space, and these bodies are masses of gas." Thus, clusters, groups, stars and planets, are in process of genesis from primeval cosmic matter, and Cosmology may be regarded as a science, established by the aid of art in the construction of larger telescopes, and their new associate in the field of stellar research, the spectroscope; these bring within the scope of observation new facts, and confirm the generally received theory of the nebular constitution and the genesis of the stellar and planetary systems from such original cosmic matter.

The conservation of all the lower departments of science to the wants of man, in his individual and social relations, gives a vast superiority of rank to Anthropology. In recent times, the chief points of practical importance in the progress or development of this science have pertained to Sociology. Researches in special lines of investigation have furnished many facts of great interest pertaining to antiquities, archives of ancient cities, inscriptions upon rocks, hieroglyphics and monuments, which have yielded abundant fruits to explorers, and vastly increased the knowledge of particular races and languages; while increasing evidences are furnished that the antiquity of the human race is much greater than that indicated by the generally accepted chronology.

In the department of Philology, great progress has been made during the period of our own times. Comparative Philology is no longer confined to the Latin and Greek of the ancient languages, and two or three of the modern languages, but every language of the globe is yielding rich fruits bearing upon history as well as philology; especially has the Sanscrit, the mother of all the Indo-European languages, received special attention, resulting in the establishment of professorships of the Sanscrit in several colleges.

But questions of the highest interest pertain to Psychology, especially relating to our psychical nature and its connection with our physiological constitution, to the phenomena of "Unconscious cerebration," and other facts which have elicited research in the modes of receiving and retaining sensations and the memory of facts, and into the medium of transmitting such impressions. Such inquiries have led to the adoption of the following theory of accounting for these phenomena, viz.: that the psychical constitution is not simply mental or spiritual, but is *dual* or two-fold, consisting of two substances we may conveniently term respectively *etheral* and *spiritual.* The following rational deductions are given as the only satisfactory hypotheses pertaining to our interior being, viz.: That the great rapidity of the transmission of impressions, being at least 100 feet per second from the extreme parts of our physical system to the brain, or requiring but one-fifteenth of a second to produce a sensation, involves the necessity of the existence of an ethereal substance permeating the nerves, and hence called "nervous ether," which forms the elementary substance of the formal psychical nature. That, as the physical germ is the initial organism of the future physical body, "potentially alive," in the germinal state, so this nervous ether contains the psychical germ or initial organism of the future psychical body, potentially perfected, and which emerges, in its real or developed form, upon the death of the physical body, or properly its separation from the soul, or interior being. That the psychical nature, while connected with the physical, forms the basis of vital action, continuity and identity; and that the mechanism of thought and feeling involves the necessity of two psychical centres of activity, corresponding with the brain and heart, viz.: the psychical *sensorium*, which is the seat of intellectual action, the basis of sensation, memory, etc., and the psychical *cardium*, the seat of the emotional and sympathetic affections.

Scientific progress has both increased the number of special sciences and extended the limits of those previously known. This has created the necessity of the division of scientific research, inducing students to pursue single lines of inquiry, the result being more thorough and extensive knowledge of the respective departments, which have become the common heritage. Examples of this devotion to special sciences are now numerous in every department, as in the case of the late Prof. L. Agassiz, who devoted many years to the study of animalculæ. In the history of plants and animals, species, genera, and even classes have been multiplied, as individuals have devoted their lives to these subjects, with all the helps at command, leaving no depths unexplored. The anatomist and physiologist no longer confine attention to the human structure, but find in comparative anatomy and physiology many types and characteristics brought forward and perfected in the higher orders, or old forms substituted by new, till finally, in the human constitution the completed form best adapted, not to the lower purposes of physical strength and endurance, by which the animal subserves human ends, but the best form for the higher ends of intellectual, moral and social natures by which man is evidently distinguished above the brute.

This division of labor has been found essential in application to the numerous sciences now demanding vastly increased forces of professional teachers in colleges and universities. Now, a college can scarcely claim the name of a liberal institution of learning in which one professor is required to associate sciences so unnaturally connected as Mathematics and Moral Philosophy, or Chemistry, Botany and Pharmacy, as in some European colleges a century ago. A comparison of the courses of study and the professorships in colleges in our country during the past thirty or forty years will exhibit the marked advancement of the sciences, and the increased requirements of the present time. In 1837, Geneva College, now Hobart College, Geneva, N. Y., of which the writer was a student, contained a professorship of "Mathematics and Natural Philosophy;" of the "Latin and Greek languagess;" of "Modern languages, History and Belles-Lettres," to which was added Rhetoric and two other mixed professorships. For the year 1849—1850, the catalogue of Western Reserve College, Hudson, O., of which the writer had been a theological student, exhibits the following: The institution embraced three departments: General Science, Medicine, and Theology, besides a preparatory department. Five professors gave instruction in General Science, or the Literary department; one of which was the professor of the "Latin and Greek;" one of "Chemistry, History, Medical Jurisprudence (in the Medical department), and Natural History,"—the latter embracing several branches, including Geology! and one professor of "Modern Languages." Great advancement upon this order is now exhibited in the principle colleges of our land. I here name only three: In 1875, Lafayette College, Easton, Pa., had twenty professors and adjunct professors, besides tutors, assistants and lecturers—twenty-seven in all. The University of Wooster, O., in 1876, had thirteen instructors in the Literary department, and the same number in the Medical department. The Michigan University, Ann Arbor, Mich., in 1877, had, in all departments, fifty-five instructors.

CAUSE OF THE BLUE COLOR OF CERTAIN WATERS.

By Prof. John Le Conte.

The consideration of certain facts clearly indicates that the real cause of the blue tints of the waters of certain lakes and seas, is to be traced to the presence of finely-divided matter in a state of suspension in the liquid. We have seen that Sir I. Newton, and most of his successors as late as 1869, ascribed the blue color of certain